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# ENTERPRISE: PERFORMANCE AND BUSINESS PROCESSES

UTILIZATION OF INTELLIGENT  
METHODS AND TECHNIQUES FOR  
CUSTOMER KNOWLEDGE  
MANAGEMENT

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**Abstract:** In order to achieve better market position, companies need to develop customer-centric strategy and properly manage customer data at their disposal in order to obtain useful knowledge. However, conversion of customer data into customer knowledge is very challenging. Data mining methods and techniques search for hidden relationships and patterns in corporate databases, and herein lies their advantage in the process of generating the knowledge. The paper illustrates application of data mining techniques for improvement of marketing activities.

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## Introduction

In nowadays business surroundings companies determined to successfully achieve better market position face with tougher competition. Their main task becomes proper management of large amounts of data at their disposal in order to obtain useful and relevant information and knowledge. Revealing the hidden information and knowledge from data and through their proper use companies can encourage their business, improve decision-making process, and develop foundation for better market positioning to always be one step ahead of the competition. Right here underlies connection between data mining (DM) and knowledge management (KM) concept. DM is the process of using one or more computer technologies in the automatic analysis and knowledge extraction from data. Essentially, DM is part of a much wider concept called Knowledge Discovery in Databases - KDD. The idea of KDD is to search for relationships and global schemes that exist in large databases, and are hidden in a multitude of data (Grljevic, Zita, 2008).

KM is an organizational practice that promotes a holistic approach in identifying, managing and exchanging intellectual property of the entire organization as well as unarticulated expertise and experience of its employees. In practice, KM often involves the creation of new knowledge, access to valuable knowledge from external resources, the use of available knowledge in the decision-making process, sharing corporate knowledge and best practice, etc. KM significantly exceeds realms of design and use of tools and technologies for gathering, analyzing and transfer of data, since its primary focus are individuals and groups as creators and users of knowledge. However, since it significantly contributes to the development of the organization and its better market positioning, any technology or method that support development and dissemination of knowledge are

considered as key successful factor of modern organizations.

This paper presents utilization of DM methods and techniques with the aim of discovering knowledge hidden in large amount of data and managing that knowledge for successful decision making about customer relationship management, and more appropriate channeling marketing campaigns towards certain customer groups.

## Research and analysis of literature sources

As stated in (Buttle, 2009), a central contribution to effective customer relationship management (CRM) is strong and leveraged customer-related knowledge that includes not only structured data (e.g. contact history, account balance), but unstructured information (e.g. letters and faxes from the customer), and also other types of information useful in marketing, selling and servicing the customer. Buttle (2009) emphasizes that fulfillment of CRM vision strongly depends on how well knowledge is deployed at customer touch-points. It should be sharable, transportable, accurate, relevant, timely, and secure. To achieve such quality of data, many companies develop an IT-based knowledge management system "which is capable of capturing, storing, organizing, interpreting (using data mining tools) and distributing knowledge to users at customer touch-points, so that marketing, sales and service objectives are accomplished" (Buttle, 2009).

As stated in Dous, Kolbe, Salomann, and Brenner (2005), CRM and knowledge management initiatives are directed towards the same goal: the delivery of continuous improvement towards customers which is labeled as customer knowledge management. The authors conceptualized customer knowledge management as the utilization of knowledge for, from and about customers in order to enhance the customer-relating capability of organizations. Authors in (Lei and Tang, 2005) shortly described these types of knowledge. Knowledge about

customers includes basic information of customers, customer purchasing tendencies and history and such. Knowledge about customers is essential for company in better understanding customers' requirements in order to satisfy successfully their needs. This knowledge can be gathered by analyzing the customer database and by utilizing DM methods and techniques. The authors explained knowledge for customers as information that customers need in their interaction with company, such as knowledge about sales, marketing, service, and information about the product. This kind of knowledge is usually implicit as it is stored as experience in the heads of salesman or employee in the marketing and service department. Since the experience is difficult to articulate, and to transfer, this implicit knowledge has to be transferred into explicit. Intelligent systems can be utilized for this purpose. Lastly, authors explained knowledge from customers as feedback information from customers on used products and services and how they perceived their purchases. This kind of knowledge helps to improve products and services.

There are different categories of IT tools for knowledge management support: computer-mediated communication (CMC) tools, content/document management systems (C/DMS), tools that will most likely use artificial intelligence (problem solving tools, intelligent agents, and DM tools), and Web portals. These tools are mapped to the knowledge life cycle in Sison (2006) as follows. During the cycle of knowledge creation following tools can be utilized: CMC, CMS or DMS, expert systems or decision support systems (ES, DSS), intelligent agents, and DM tools. During the knowledge transfer and knowledge use cycles, it is desirable to use CMC, CMS, DMS, ES, DSS, or intelligent agents. This article will present how DM tools can be used for knowledge creation of customer related knowledge in financial sector of business.

### Utilization of data mining in CRM

CRM should help customer acquisition and retention, and increase customer satisfaction, so these actions would positively reflect on companies' profit. To achieve this, a company must develop customer centric business model that will be linked with marketing, sales and servicing the customers. The underlying goal of CRM is better comprehension of customer behavior, their needs and preferences, so the company can take this knowledge into account to better suite specific customer needs and build long-term and trustworthy relationship with customers that will also provide a company a better position in the market.

One of the CRM types, asides of strategic, operational, and collaborative, is analytical. Analytical CRM is focused on application of intelligent methods and techniques on information about customers. These results contribute to improvement of sales, adaptation to the characteristics of individual segments, increase of efficiency of cross-selling and up-selling, retention, and attraction of customers, etc. (Buttle, 2009.).

The central idea of data mining in CRM is that past data contain information useful for future, since gathering information on customer behavior reflects diversity of needs, preferences, affections, and the way to treat a customer. The goal of DM is to find such patterns in

historical data that will add new knowledge about needs and preferences of customers. This task is extremely difficult because the patterns are not always clear. The signals sent from the user could contain "noise" and therefore be confusing. Identifying the basic model under the seemingly random variation is an important DM task (Berry and Linoff, 2004).

DM is used in CRM for a) prediction of the prospects, the choice of communication channel, selection of the appropriate messages to potential customers; b) improvement of direct marketing; c) customer segmentation; d) credit risk decrease; e) increase of business profitability through cross-selling and up-selling, where DM helps in defining the timely supply for the right group of customers; f) customer retention and identification and prediction of churn rate.

To achieve different DM tasks one could use different techniques. *Decision trees* are suitable technique for classification and prediction tasks. *Neural networks* are used for clustering tasks, in addition to previously stated tasks. *Nearest neighbor* algorithm is used to search for similarities. *Market basket* analysis represents extremely important retail analysis, it helps to identify goods that customers often buy together and time spent on purchase. *Association rules* are closely related with previous analysis; it captures independent patterns in data, without a defined goal. *Link analysis* allows more detailed insight into the web links that user's visit and their sequence. *Clustering* algorithms provide means for better understanding of structure of complex data, and when appropriate clusters are defined there is often a possibility to identify simple patterns in each of them. The application of each of these techniques brings new information and increases knowledge about customers by helping companies to better conceptualize their activities, improve relationships with existing and develop relationships with potential customers and increase their satisfaction with the company and the services or products offered.

### Case study

The fundamental principal of business strategy becomes personalization of company's offer according to needs of target consumer groups. These groups are identified in the process of customer segmentation that facilitates analytical division of existing customers based on different criteria into internally homogenous, but externally heterogeneous groups. This kind of segmentation allows companies to direct their marketing efforts on particular segment and to identify prospects with same preferences. The data needed to assess the consumer and to develop their models are in the companies' customer databases. Customer segmentation is often performed in banking sector. In order to effectively promote the banks services and to target those customers who would likely respond positively to the offer and the conditions, banks derive groups/clusters of clients with the same characteristics from a database, or perform classification of data according to predetermined criteria.

In order to illustrate such marketing approach, Census Income (Frank, Asuncion, 2010) dataset was used. The aim of the analysis is to classify data on those who earn more than USD 50000 annual income and those who earn

less. Based on constructed classification model it will be possible to successfully classify an unknown person with the same criteria. Analogous to this example, banks are classifying their data in order to identify target groups that will most likely react positively to their offer (in the example, if the assumption is that people who earn more than USD 50000 a year are more creditworthy customers such classification model would enable the bank to check accuracy of the assumptions, and if true to directly target those with higher incomes, instead of randomly selecting the target group).

Census Income dataset includes 14 attributes: age, wage, education, occupation, marital status, gender, capital-gain, and capital-loss, to state just few. These attributes are used as inputs for data classification according to annual income. Since there were some missing data in the dataset, in order to illustrate the application of DM in detection and management of knowledge, the smaller dataset without missing values was extracted. The analysis was performed in Weka<sup>1</sup> tool and classification was conducted by Weka's J4.8 decision tree learner algorithm.

### Results

Analyzing the distribution of values of all attributes, we found that a significantly greater number of instances are those with annual incomes of less than USD 50000 than those with incomes greater than USD 50000. We also got initial insight about the data: the majority of instances are young people, from 20 to 40 years old, with 8 to 10 years of education, and mostly they are Caucasian men who work 40 hours per week in the private sector.

During the construction of decision tree, data were divided into training and test set in order to assess the performance of prediction model. Some of the interesting rules that illustrate generated decision tree reveal following information: 1) people who have capital gain less than or equal to 5013 dollars and are younger than 29 years have annual incomes less than 50000 dollars (of 409 instances that have reached this leaf in the tree 13 were incorrectly classified), 2) people with the same as previous capital gain but are older than 29 years, live in a marriage, have capital loss less than or equal to 1762 dollars, have a college degree or have lower education, employed in state firms, and have children, or other relatives to support, earn less than 50,000 dollars per year. Additional interesting conclusions are derived from the data, particularly for different groups of job, age and race (due to length limitation of the article they are not discussed in more detail).

Special interest was devoted to performance evaluation of the model on test set, since this is a real indicator of how well the model will work with unknown data. Analyzing Weka summary on test data, it was established that classification error is 18%, i.e. from 510 instances in test set 93 instances are classified incorrectly. Confusion matrix showed that the majority of incorrectly

classified instances are from the class of persons with income greater than 50000 dollars. Through further analysis it was revealed that most of these instances have almost the same number of characteristics that distinct the other class. By visualizing classifier errors it was determined that incorrectly classified people in most cases have atypical earnings for their age, education, or the job, or have similar capital gain/loss as the people belonging to the class of income less than 50000 dollars.

Regardless of the classification error, model performs solid prediction of people earning more than 50,000 dollars per year, and will with relative degree of accuracy classify new people into an adequate class. By analogy, a financial house (or companies in general) can build classification models in order to target exclusive group of people who are the most suitable for certain offer.

### Conclusion

Following the historical development of CRM, it is obvious that CRM is increasingly important in market-oriented organizations. Building a business approach that should provide centralized information about customers, improve interactions and customer focus, and with the help of software tools, companies also build their competitive advantage. Analyzing only some of the aspects of CRM domain related to implementation and incorporation of knowledge, leads to the conclusion that KM, CRM and DM concepts are inter-linked. CRM can be supported by different tools and techniques aimed at knowledge management and increase of intellectual capital of organizations. DM tools are one of them. They increase the quality of data, information and knowledge management in organization.

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<sup>1</sup> Waikato Environment for Knowledge Analysis (Weka) is an open-source collection of machine learning algorithms for data mining tasks, maintained by the University of Waikato, New Zealand. For details see <http://www.cs.waikato.ac.nz/ml/weka/>